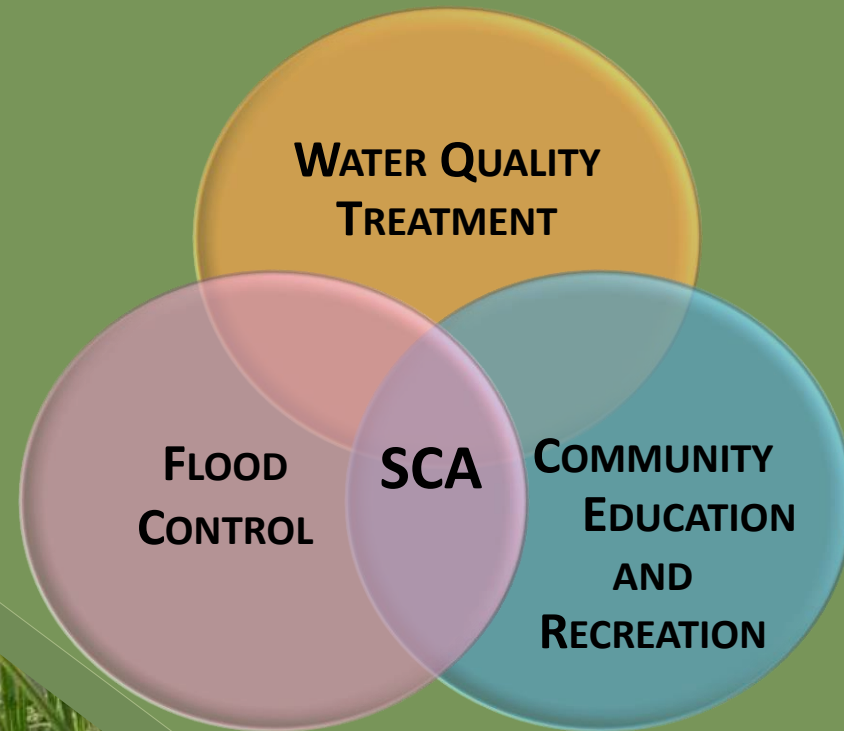


# Shiloh Conservation Area (SCA) – City of Billings:

**Presented by:**

Wade Irion, P.E.  
DOWL

Greg Gabel, P.E.  
DOWL



# Today's Presentation

- ▶ Project background and Objectives
- ▶ Data Collection
- ▶ Flood Control Design
- ▶ Orientation and Site Layout
- ▶ Water Control Structures
- ▶ Wetland Design
- ▶ Community Education and Recreation
- ▶ Construction
- ▶ Questions





## Community Education & Recreation



## Water Quality

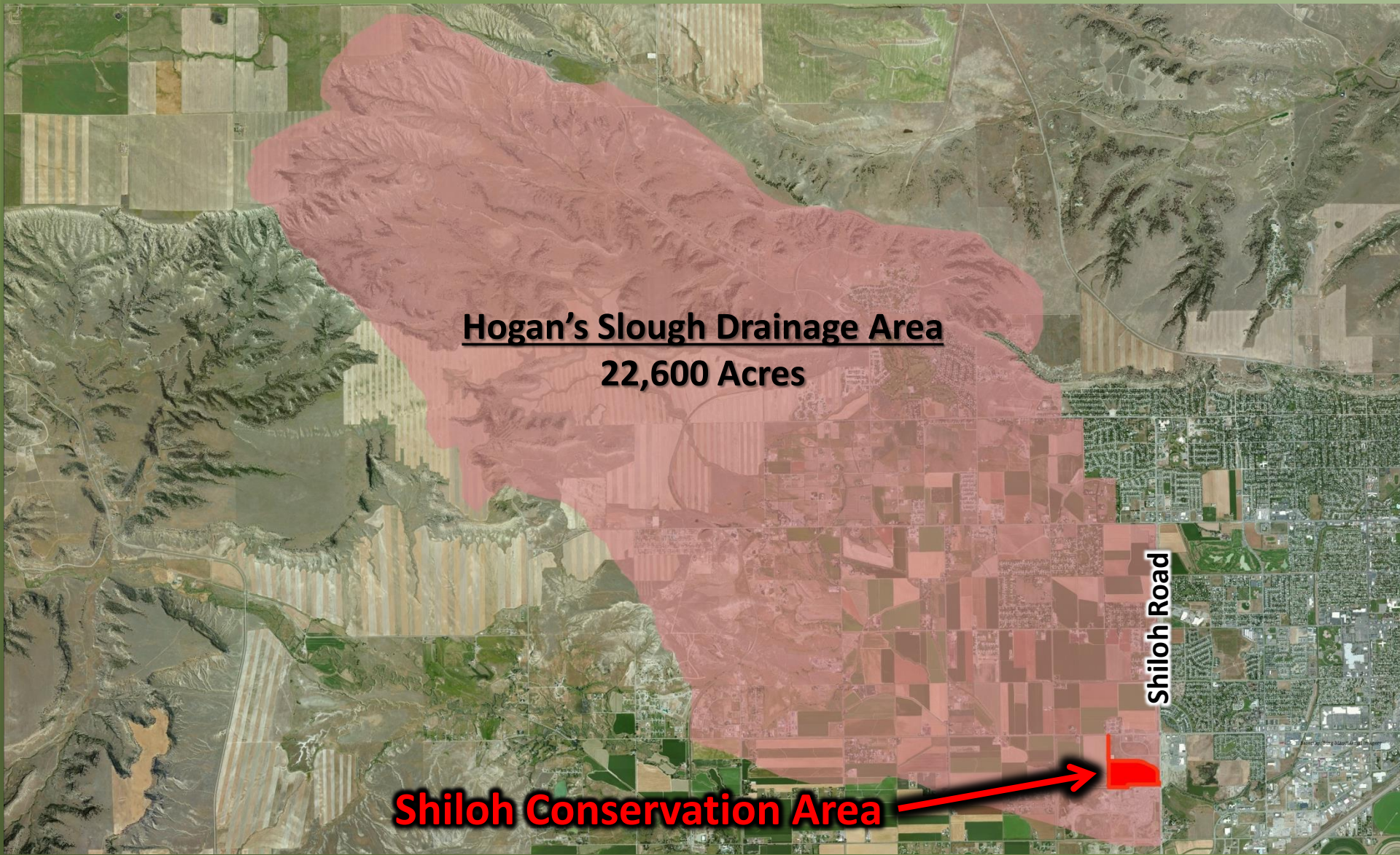


## Flood Control



# Project Background

- ▶ Large Drainage Basin of West Billings



**Hogan's Slough Drainage Area**  
**22,600 Acres**

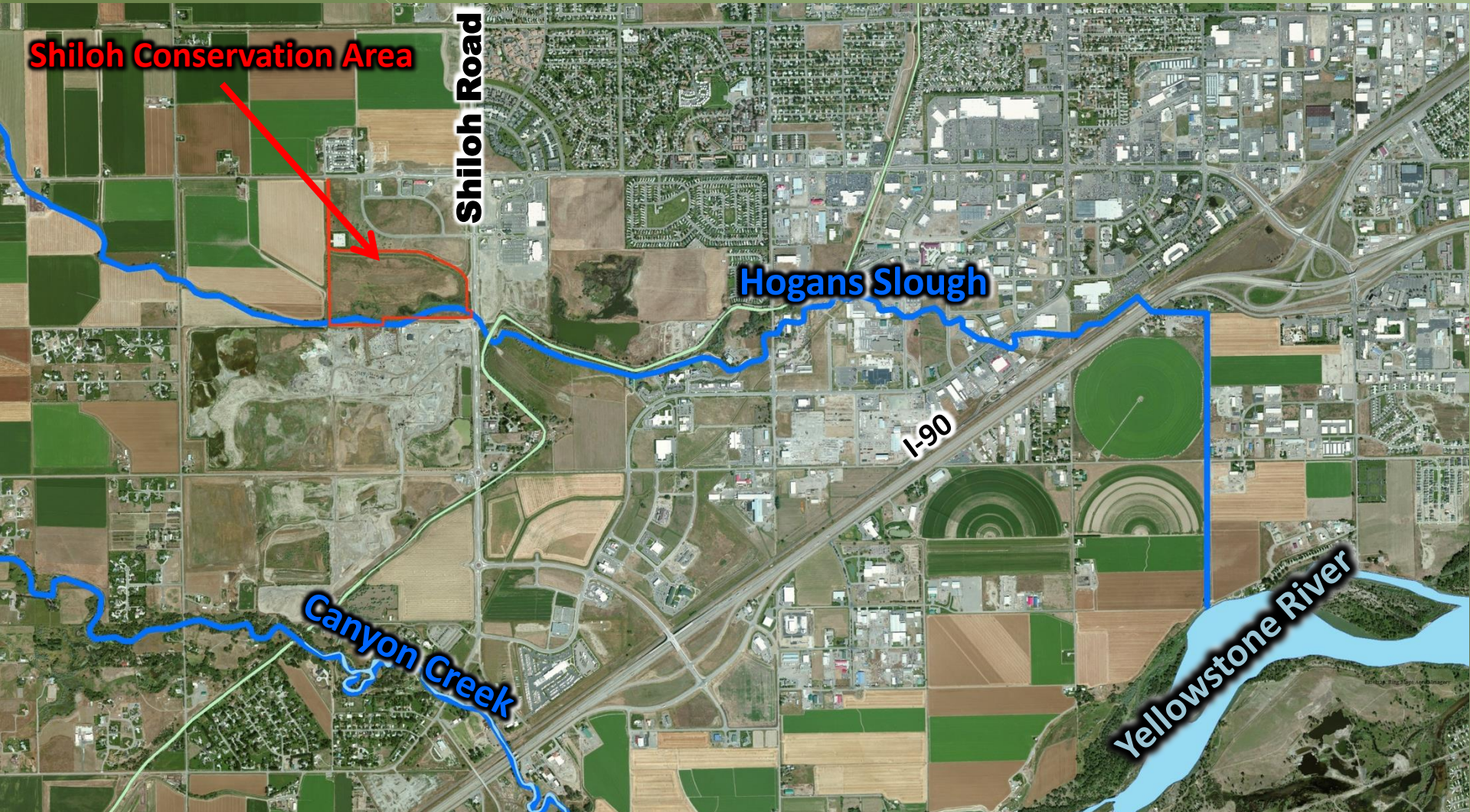
**Shiloh Conservation Area**

Shiloh Road



# Project Background

- ▶ Limited downstream capacity in Hogan's Slough
- ▶ Increasing development of West Billings and Future MS4 Requirements
- ▶ Proximity to Heritage Trail Network





# Project Background

## ▶ Previous Studies

- ▶ 1970 US Army COE Flood Mitigation Study
- ▶ 1991 West Billings Stormwater Master Plan Study
- ▶ 1996 HKM Lower Hogan's Slough Study
- ▶ 2007 West Billings Flood Hazard Study
- ▶ 2011 West Billings Flood Mitigation Study

### LOWER HOGAN'S SLOUGH STUDY



Prepared for:  
**CITY OF BILLINGS**  
BILLINGS, MT



Prepared by:  
**HKM ASSOCIATES**  
ENGINEERS-PLANNERS

2727 Central Avenue  
P.O. Box 31318  
Billings, Montana 59107

Branch Offices:  
• Sheridan, Wyoming  
• Bozeman & Miles City, Montana

West Billings Flood Hazard Study  
Project No. B20016

**FINAL**

### Hydrologic & Hydraulic Analyses Report



Prepared For:

City of Billings  
Yellowstone County  
Montana

May 21, 2007

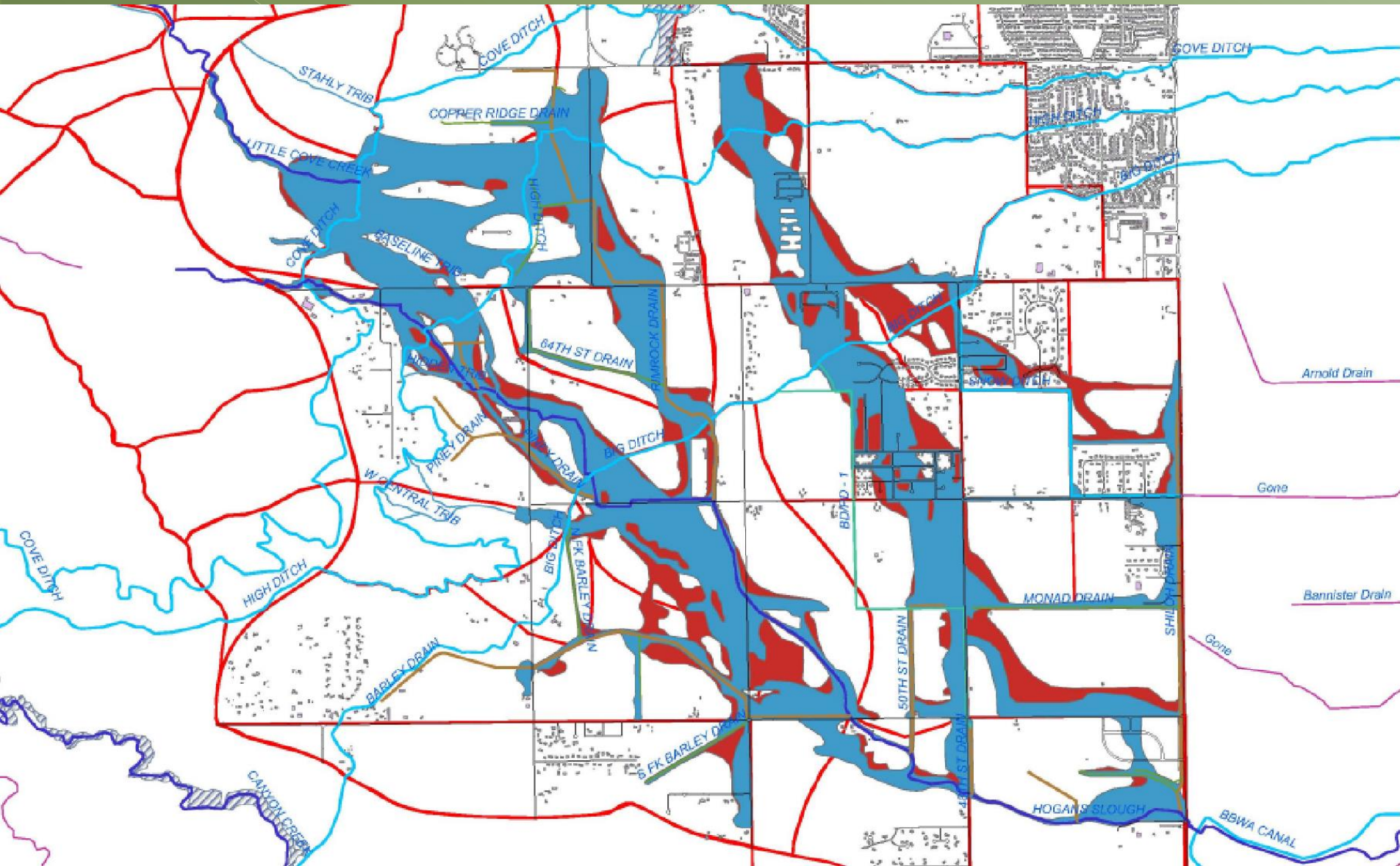


3810 Valley Commons Drive, Suite 4  
Bozeman, MT 59620  
Phone: 406.587.7275 Fax: 406.587.7276  
www.pbsj.com



# Project Background

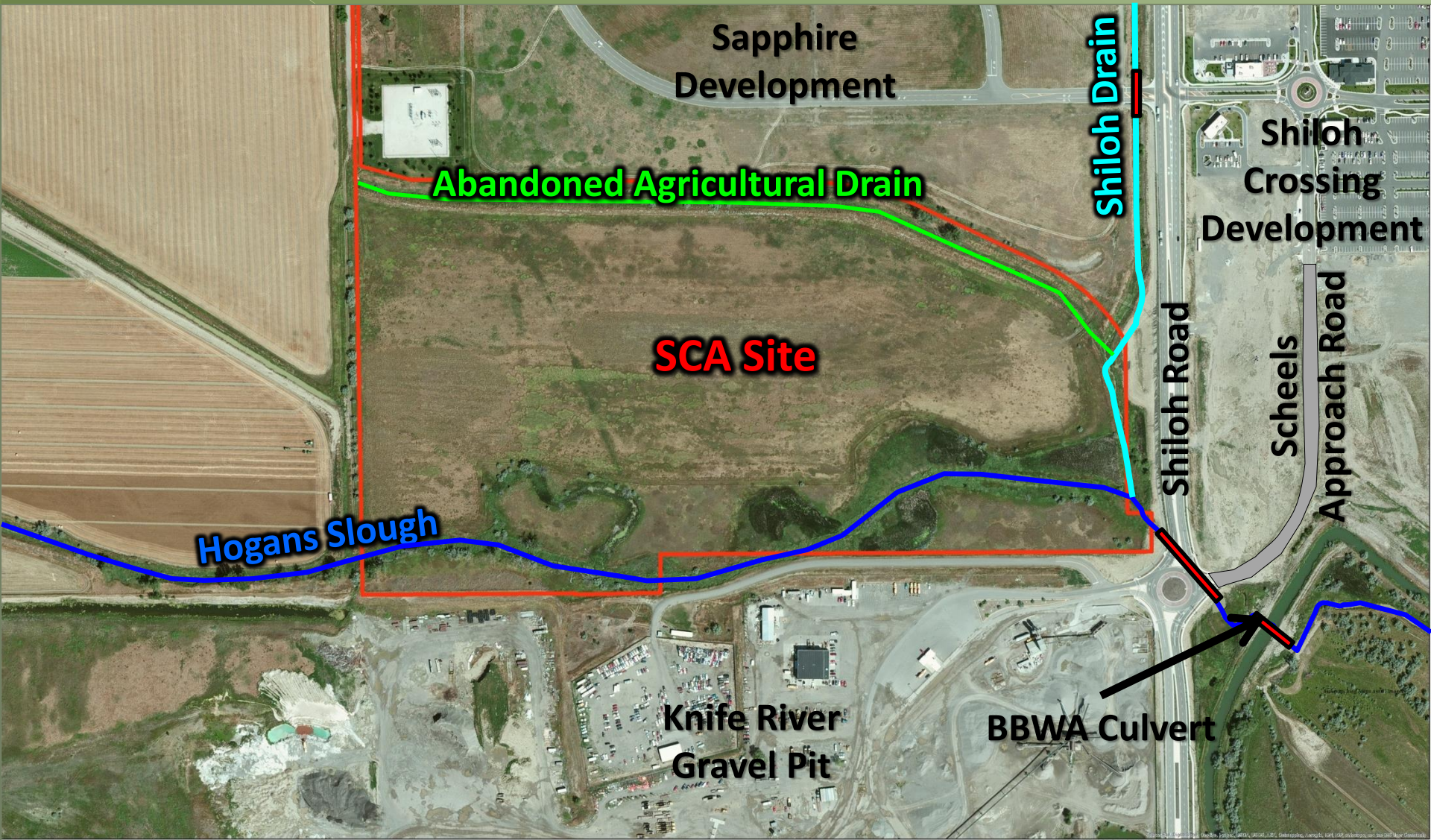
## ▶ 2007 100 & 500-year Floodplain Boundaries





# Project Background

## ► Pre-project Conditions





# Data Collection

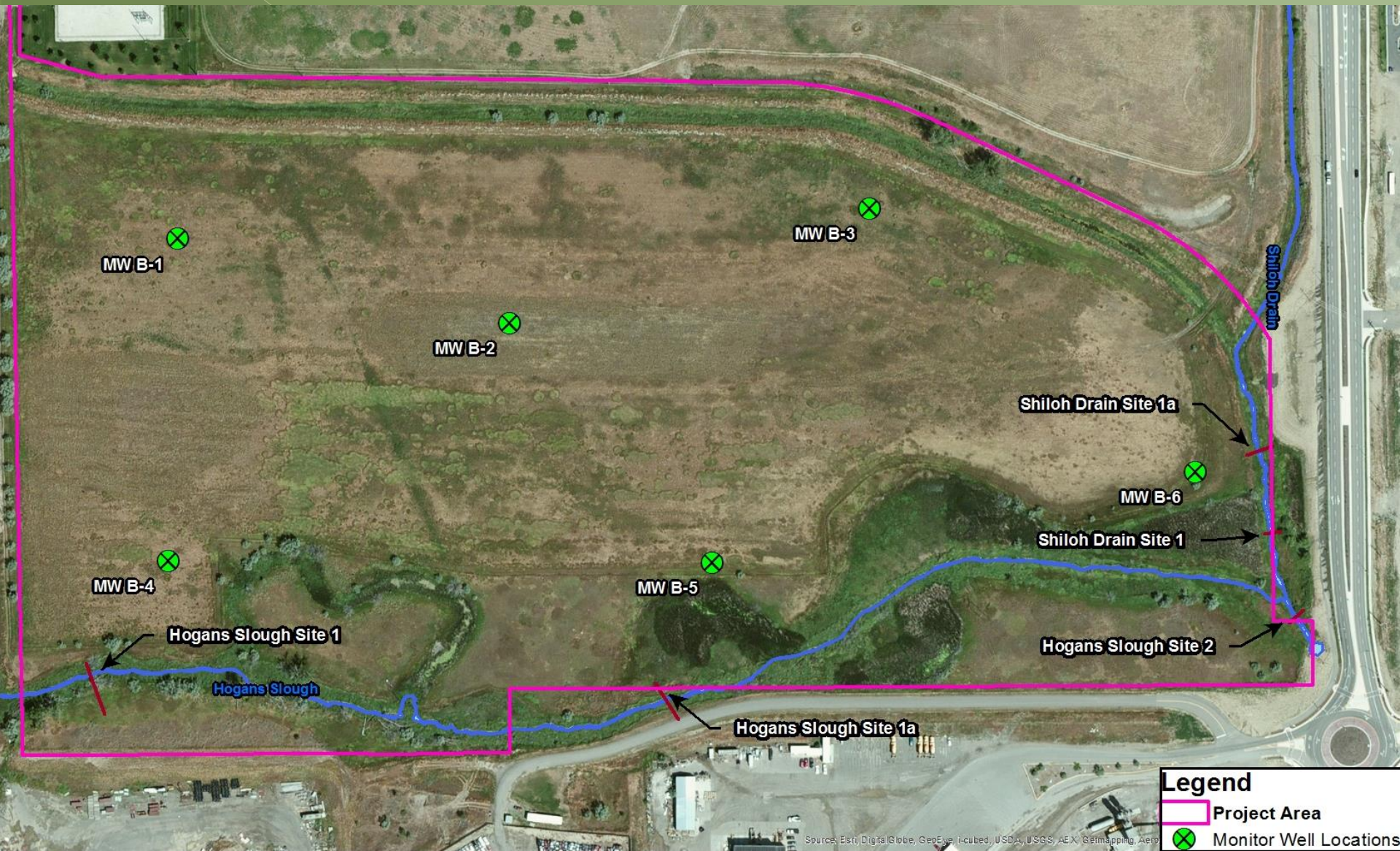
- ▶ Geotechnical Investigation
- ▶ Groundwater Monitoring
- ▶ Baseline Water Quality Sampling
- ▶ Flow Measurements
- ▶ LiDAR and Ground Surveys





# Data Collection

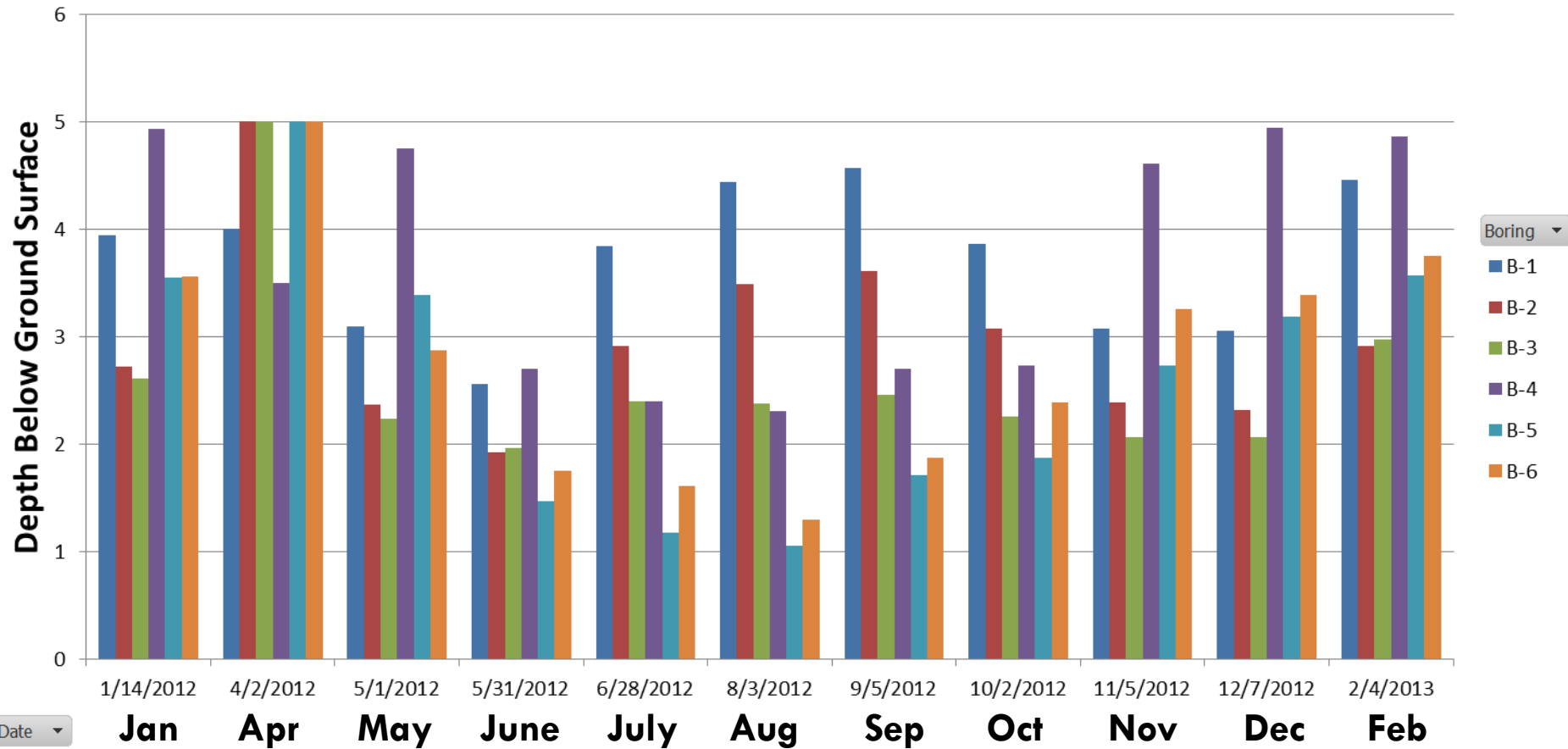
## Groundwater and Surface Water Monitoring






# Groundwater Levels

Average of Measured Depth Below Ground Surface (ft)



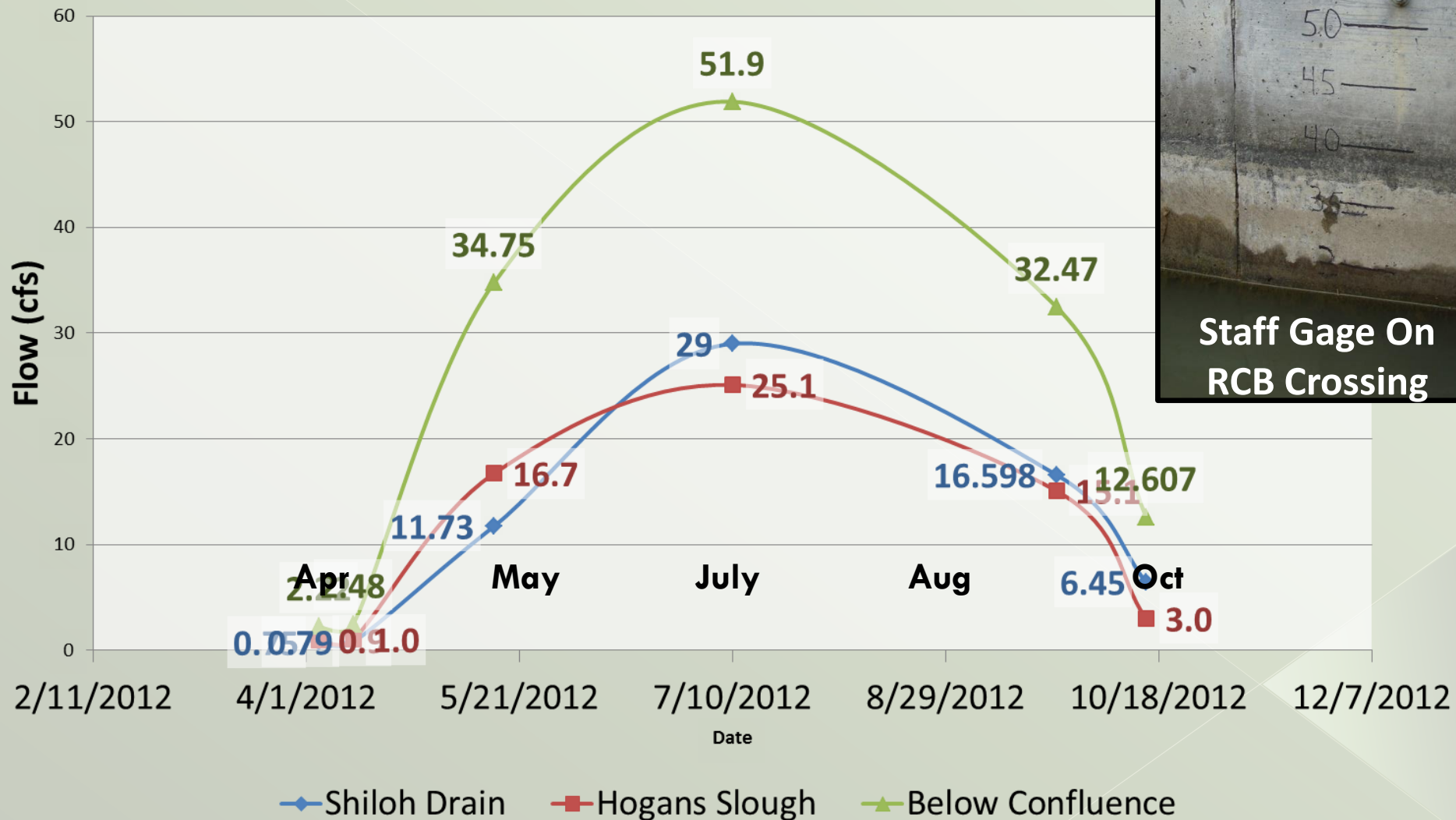
# Substrate

- ▶ Gravel Pits use to surround this site
- ▶ No gravels, mostly lean clays and sands

Project No.: 4025.20340.01		LOG OF BORING B-1				Sheet 1 of 1								
CLIENT City of Billings			PROJECT Shiloh Conservation Area											
SITE Billings, Montana			BORING LOCATION See Boring Location Map											
DEPTH (FT.)	MATERIAL DESCRIPTION	GRAPHIC LOG	ELEVATION (FT.)	SAMPLES				TESTS				ADDITIONAL DATA/REMARKS		
				BULK DRIVE/PUSH	BLOWS PER FOOT	NUMBER	IN. RECOVERED IN. DRIVEN	POCKET PENETROMETER TIF	PL	M.C.	LL			
0.0	Topsoil - approximately 6-inches thick.		0.0											
0.5	Lean Clay with Sand (CL) - brown, moist to wet, fine sand, scattered fine to coarse subrounded gravel.		0.5											
1.0			1.0											
8.0			8.0											
12.0			12.0											
15.0	Poorly Graded Gravel with Silt and Sand (GP-GM) - brown, wet, fine to coarse sand, fine to coarse subrounded gravel, cobbles present.		15.0											
17.5	Shale - gray, soft rock.		17.5											
20.0	End of boring at 20 feet.		20.0											
24.0	Groundwater encountered at approximately 4 feet while drilling. Boring completed as a temporary piezometer.		24.0											
28.0			28.0											
			DOWL HKM 222 N. 32nd Street, Suite 700 Billings, Montana 59101 Telephone: (406) 656-6399 Fax: (406) 656-6398				STARTED 4-2-12 FINISHED 4-2-12		DRILL CO. Haztech DRILL RIG BK-81		DRILLER PB HAMMER Auto		LOGGED BY SW CHECKED BY JP	



# Surface Water Flows Over Time



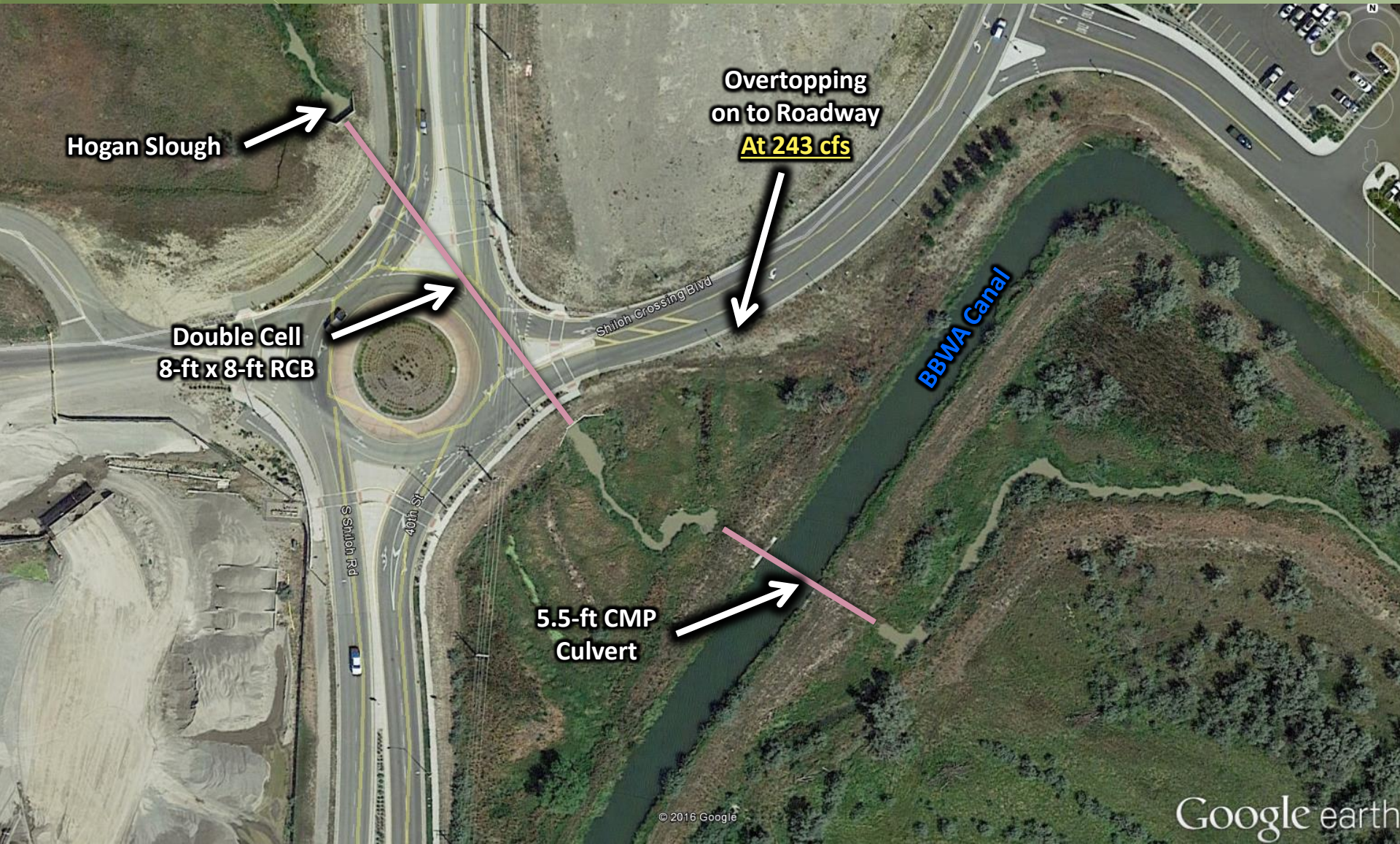
# Water Quality Sampling Results

Site	pH (s.u)	TSS (mg/L)	COD (mg/L)	Total N (mg/L)	Total P (mg/L)	Total Cu (mg/L)	Total PB (mg/L)	Total Zn (mg/L)	Oil & Grease (mg/L)
Hogans	8.2/7.8	11/132	21/12	4.9/3.2	0.029/.37	0.012/ 0.005	ND/0.003	0.01/ 0.02	ND/ND
Shiloh	8.0/7.9	ND/576	10/22	12.0/3.0	0.02/0.92	ND/ 0.017	ND/0.012	ND/ 0.07	ND/4
Outlet	8.1/7.8	ND/426	17/12	7.6/3.2	0.026/ 0.82	0.008/ 0.014	ND/0.009	ND/ 0.06	ND/ND

- ▶ Each of these are **within the typical range** of inputs from stormwater where wetlands, vegetated swales, and other Low Impact Development (LID) strategies are used to address water quality.



# Flood Control Design





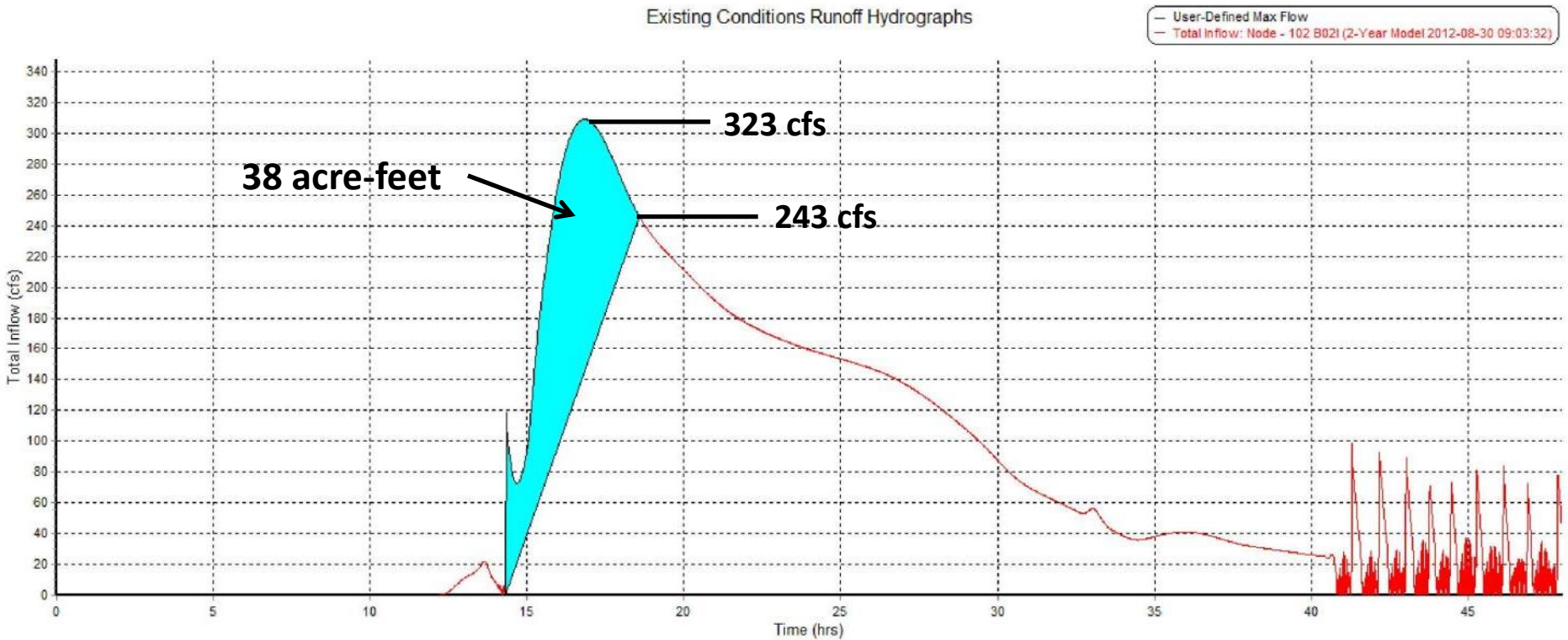
# Flood Control Design

- ▶ Design Flood
  - ▶ 2007 West Billings Flood Hazard Study stands as the most current evaluation of West-end hydrology
    - ▶ 323 cfs at the 2-year
    - ▶ 690 cfs at the 100-year
  - ▶ Typical Weather Patterns
    - ▶ High Intensity Short-Duration Storms
  - ▶ Billings experienced 100-year storm events in 2010 and 2011
    - ▶ Highwater marks indicated a maximum flow on the order of 100 cfs
    - ▶ 323 cfs is more severe than the 2-year
  - ▶ **SCA detention storage is sized to reduce the 2-year design flood**
    - ▶ Likely considerably greater protection than the 2-year flood
    - ▶ This is just one component of the ultimate Hogan's Slough Flood Mitigation Plan





# Required Flood Storage



❑ Site Layout provides for 49.6 acre-feet of storage



# Site Layout





# Water Control Structures

## ▶ 18 Water Control Structures





# Base & Flood Flow Operation



## Flood Flow Operations



# Pond 1 Outfall Structure

- ▶ Primary Flood Control Structure for Hogan's Slough
  - ▶ Designed to handle base flows and flood flows

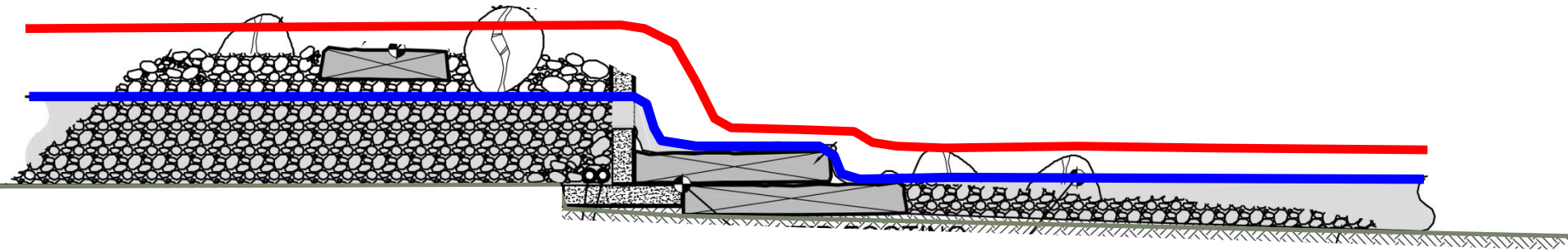




# Pond 1 Outfall Structure

**Base Flow Operations**

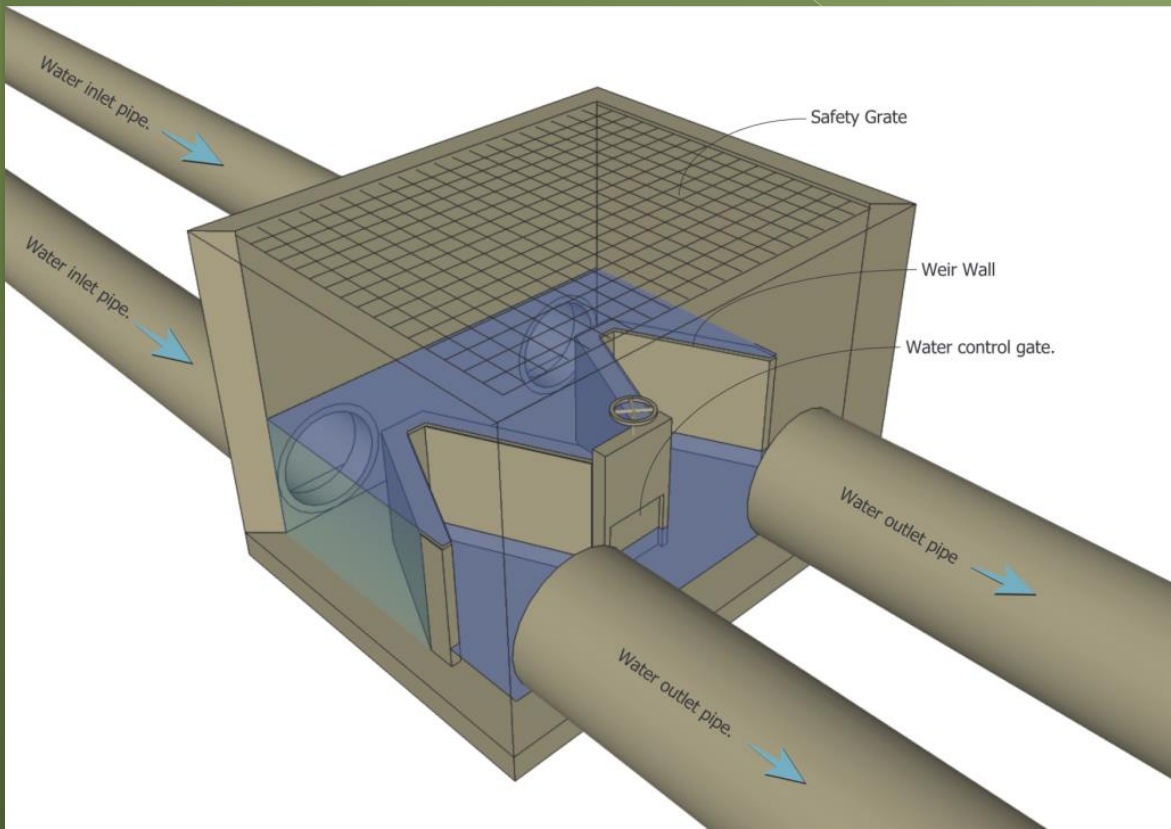
**Flood Flow Operations**





# Pond 2 Outfall Structure

- ▶ Flood Control Structure for both Hogan's Slough & Shiloh Drain





# Other Water Control Structures



**Wetland Cell 10 Rock Weir**



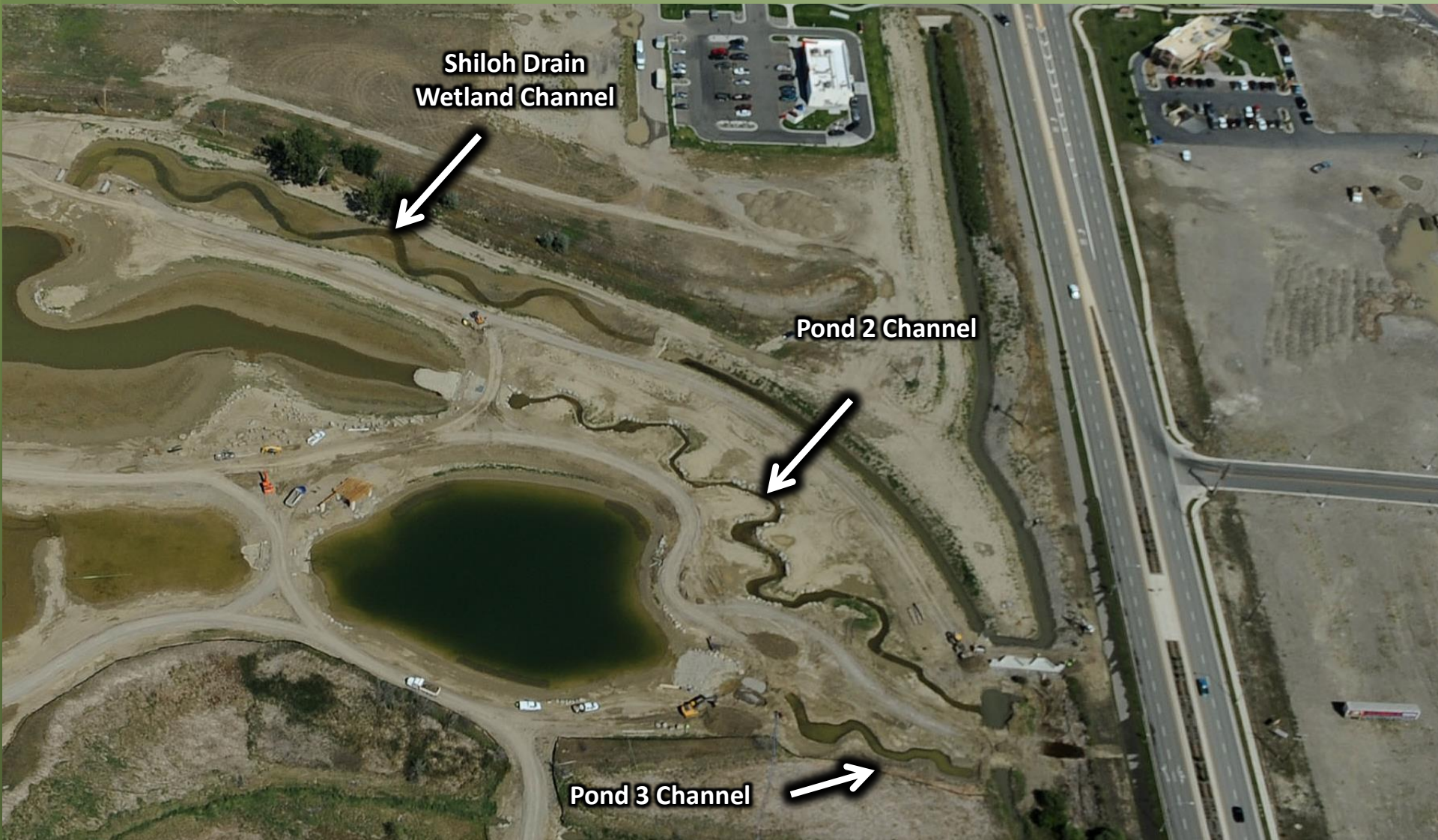
**Pond 3 Rock Weir**



**Shiloh Drain Diversion Structure**



# Conveyance Channel





**Pond 2 Channel under High flow**



**Shiloh Drain Wetland Channel**



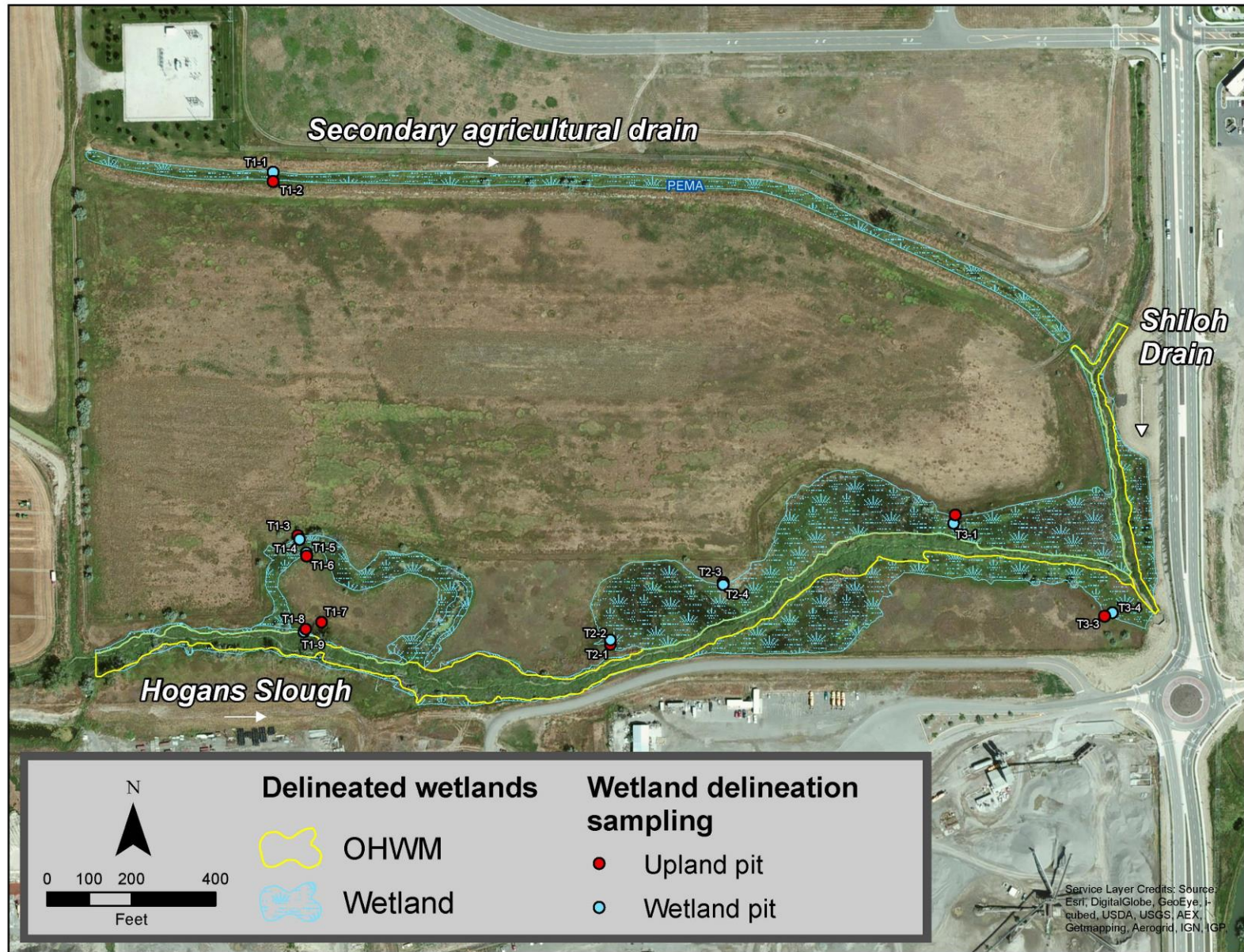
**Pond 2 Channel  
Low flow with landscape plantings**

**Shiloh Drain Wetland Channel**





# Wetland Design





# Reference wetland vegetation





# Shiloh Design Concept



0 75 150 300 Feet

## Wetland Complex Components

- ✕ Russian olive Removal
- Headgate
- Pipe

- ▨ Middle Marsh
- ▨ Deep Marsh
- ▨ Shallow Marsh

- ▨ Vegetated Buffer
- ▨ Transition Slope
- ▨ Pond-ED

- Pond
- Sediment Pond
- ▨ Existing Wetland Floodplain



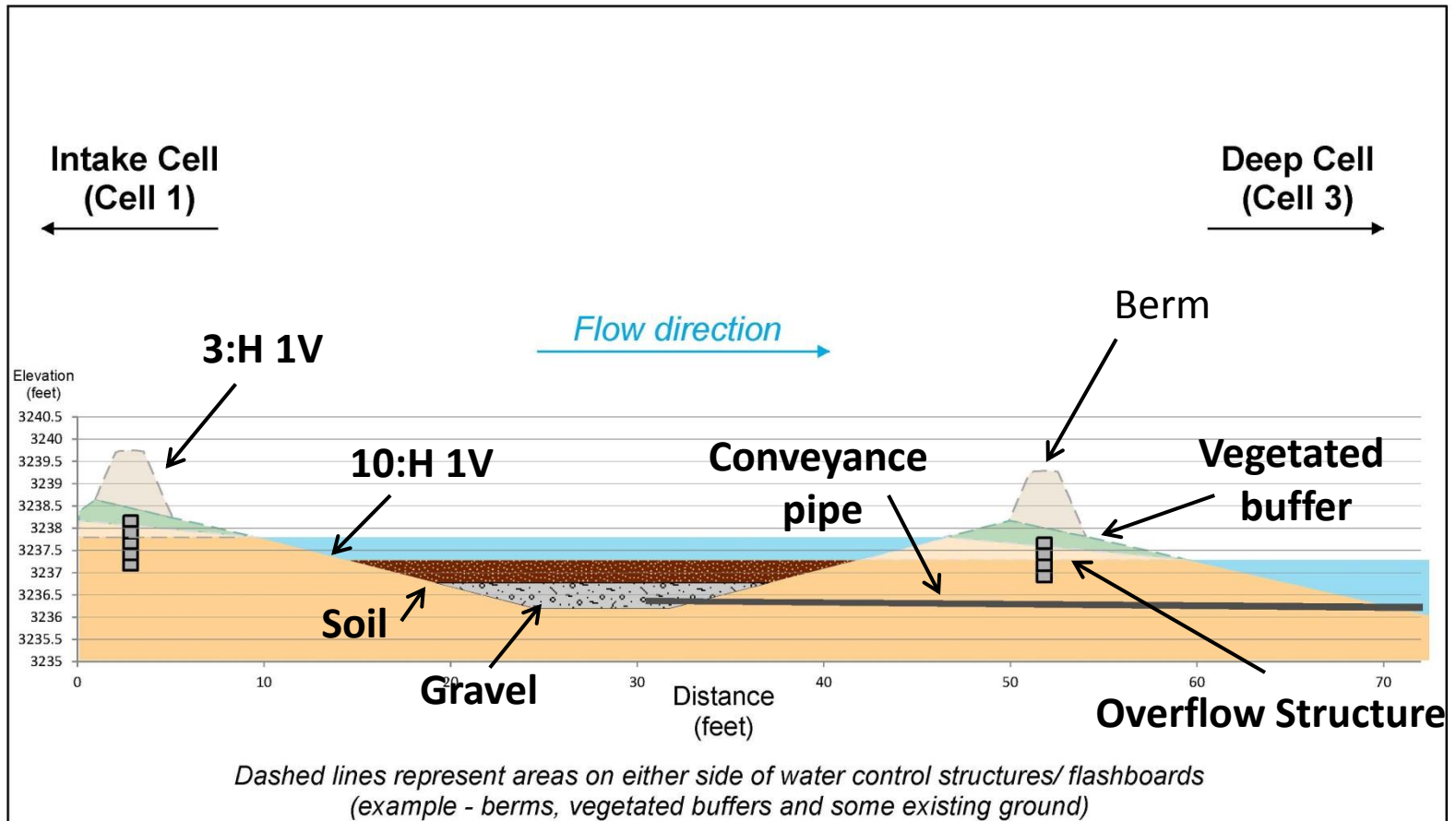
- ▶ Sediment ponds
- ▶ Detention ponds

- ▶ Wetland fringe
- ▶ Wetland cells

- ▶ Diversity



# Wetlands – Shallow cell





# Shallow Cell

Pea gravel over geosynthetic fabric

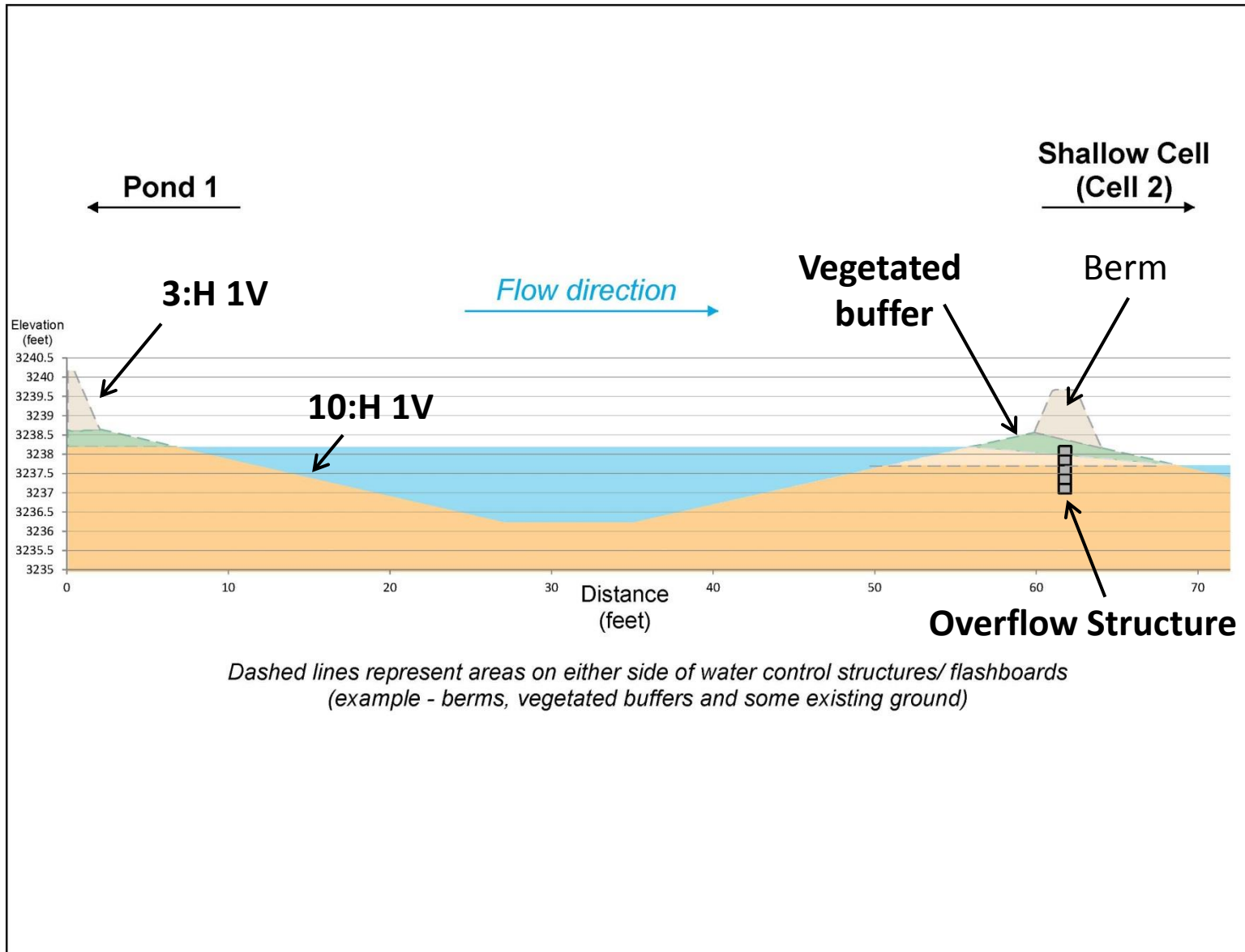


Soil over pea gravel showing low-flow channel





# Wetlands - Deep cell/Intake cell





# Wetland Cells

**Cell 9 : Shallow Cell**



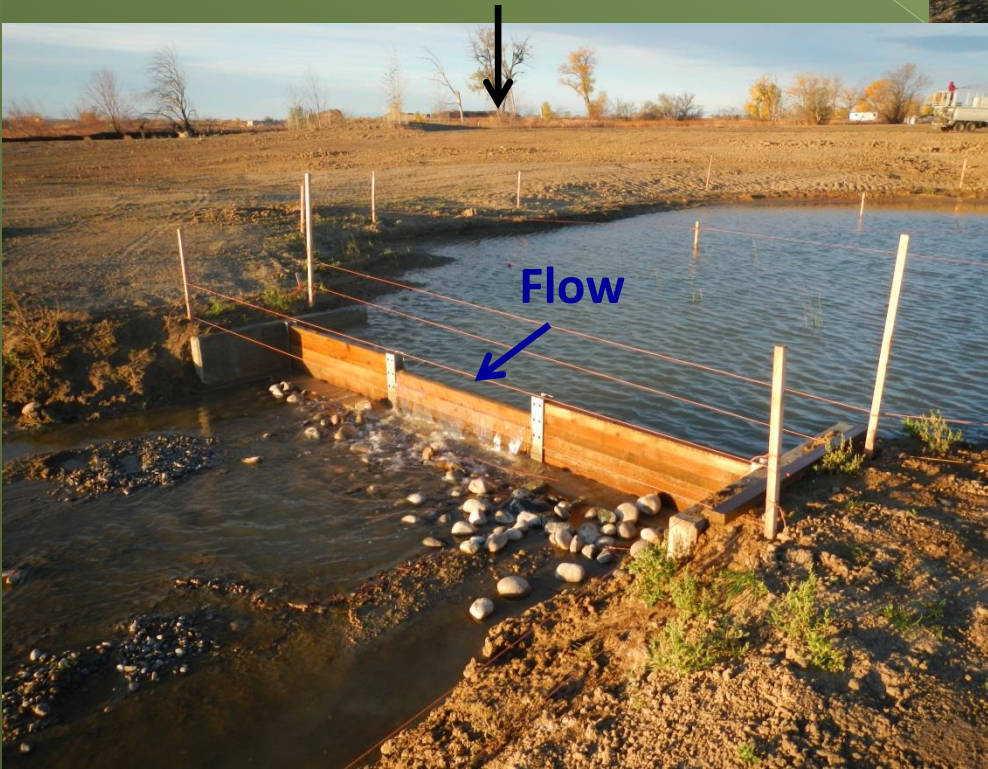
**Cell 6 : Deep Cell**





# Wetland Cell Water Control Structures

Wetland Cells 1 & 2 structures



Wetland Cells 6 – 10 structures



# Pond 2



After installation (early July)



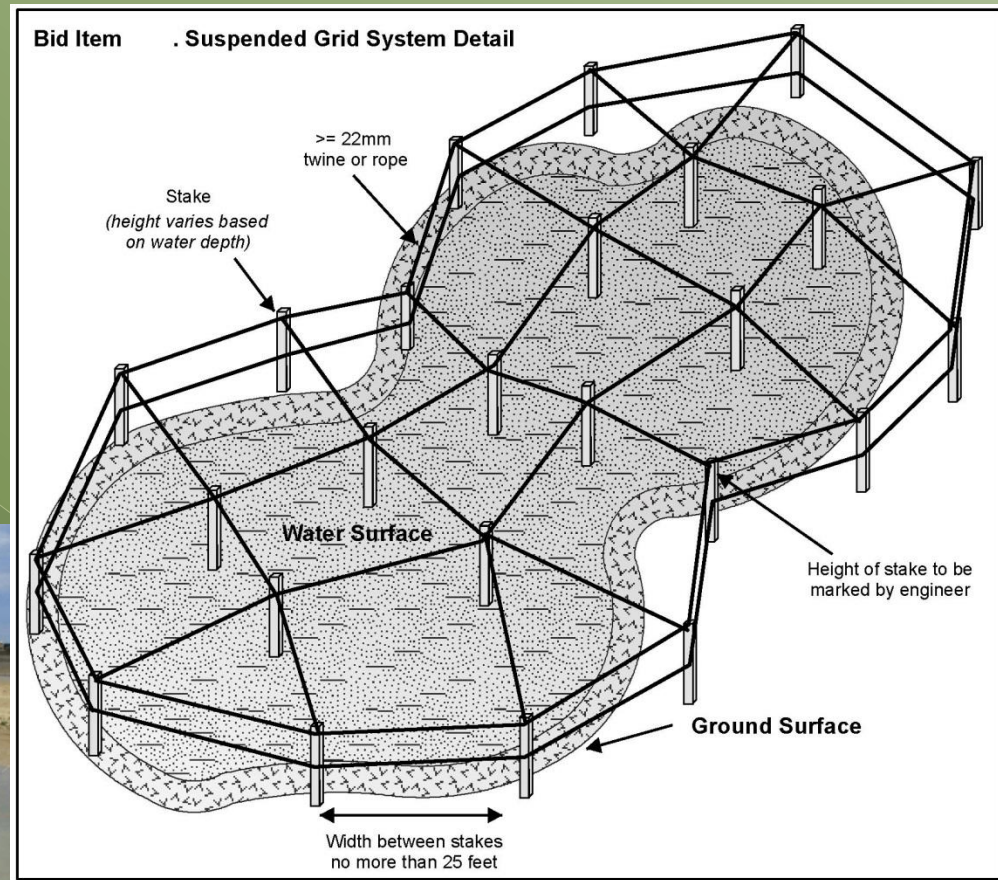
Three weeks later





# Browse Control—Suspended Grid System

- Ponds – open water
- Cells – closed system



09/22/2014 14:03



# Recreational Opportunities

- ▶ Passive Use Recreation
- ▶ Urban Fishing
- ▶ Primary Shelter





# Recreational Opportunities

- ▶ 1.85 miles of Trails and Access Paths





# Aesthetic Enhancements





# Educational Opportunities

- ▶ Interpretive Signs
- ▶ What is the purpose of the project?
- ▶ How does it function?





# Educational Opportunities

## Labyrinth Weir

**WHAT IS A WEIR?**  
A weir is a structure that is built across a water body to back up water and control water level and flow. The structure you see in front of you is called a Labyrinth Weir. Labyrinth weirs are one of the primary water control structures utilized in the Shiloh Conservation Area.

**HOW LABYRINTH WEIRS WORK**  
In the illustrations below you can see the length of a typical straight weir. Its length is noted as "A"



STRAIGHT WEIR

In the next illustration you can see the labyrinth weir has the same length "A" as the straight weir wall. However, you can see that the effective length of the labyrinth weir when it is straightened out is actually two times the length of the straight weir. This reduces the water surface elevation as it passes over the weir.



LABYRINTH WEIR



LABYRINTH WEIR STRAIGHTENED



**Why are labyrinth weirs important?**  
The weir needs to be able to pass storm water flow raising the upstream water level too high. A straight weir require the water to back up approximately 60% higher than the labyrinth weir.

## What is a Wetland?

In a wetland, the water table is close to the ground surface during the growing season, waterlogged soils develop special characteristics, and plants are adapted to saturated conditions. Thus, wetlands have wetland "hydrology", "hydric" soils, and "hydrophytic" vegetation.



**WETLAND HYDROLOGY**  
Soil is inundated or saturated, or water is present within the rooting zone, during a portion of the growing season.

**HYDRIC SOIL**  
Hydric soils are poorly drained and develop under anaerobic (low oxygen) conditions. These soils can either have dull colors where oxygen is completely absent, or bright spots where metals concentrate due to regular cycles of saturation and drying.

**HYDROPHYTIC VEGETATION**  
Wetland plants are water loving, or "hydrophytic" because they have special adaptations that allow them to survive in saturated soils. Some wetland plants have special "aerenchyma" cells that function like snorkels and allow plants to move oxygen from above the water surface to their roots.

**Did you know?**  
Wetlands are found throughout the world from the tundra to the tropics.



# Contracting

- ▶ Construction Cost - \$4.25 million
  - ▶ Concurrent CTEP Trail Project - \$470,000
- ▶ Construction began Fall of 2013
- ▶ Completed in October 2014





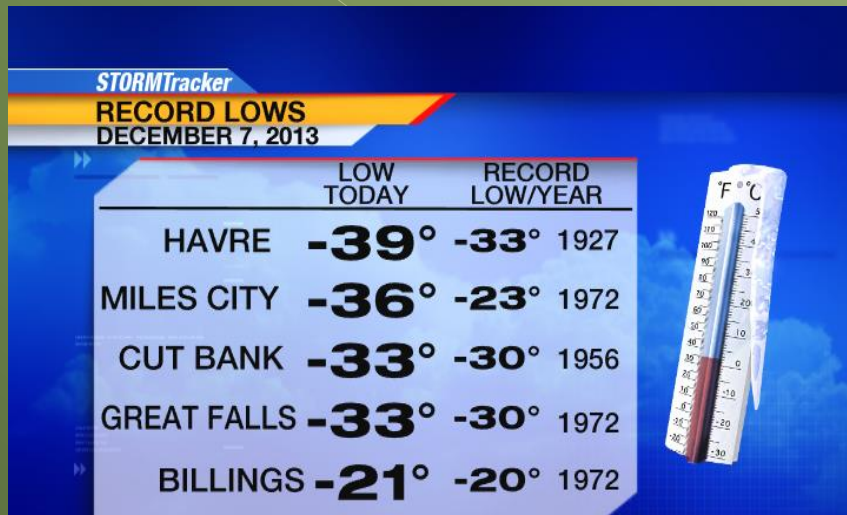
# Contracting – Quantities

- ▶ 185,000 CY of material to haul – 95,000 CY hauled away
- ▶ 1.85 miles of maintenance/pedestrian trails w/ H20 load rated bridges
- ▶ 305 trees, 1300 shrubs and perennials
- ▶ 24-acres of seeding
- ▶ 760 TN of boulders – not including slab and block rock
- ▶ 120,000 individual wetland plants – grown a year in advance
- ▶ 6,300 SY of GeoWeb and miles of geofabric



# Construction Challenges - Weather

## ► Billings Gazette and KTVQ-2





# Construction Challenges - Dewatering





# Construction Challenges – Clay/Silty Soils





# Construction Challenges – Ditch Flows





# Construction Challenges – Structures





# The Water Is Flowing





# Wetlands & Upland Vegetation is Establishing





# Significant Wetland Growth in Shallow Wetland Cells





# On Going Growth in Deep Wetland Cells





# The Community and Wildlife Loves It





# Questions?

